

CIS 730 Artificial Intelligence
CIS 530 Principles of Artificial Intelligence
Fall 2007

Homework 6 of 10: Machine Problem (MP6)
Constraints and Logic, Part IV:
More Clausal Form and Prolog with Applications to Planning

Assigned: Tue 23 Oct 2007
Due: Wed 31 Oct 2007 (before midnight)

The purpose of this assignment is to exercise your basic understanding of logical syntax, semantics, and knowledge representation through implementation of a system for parsing FOL sentences and converting them to clausal form.

This homework assignment is worth a total of 20 points.

Each problem is worth 4 points for CIS 730 students and 7 points for CIS 530 students.

Upload a copy of your solution (scanned or typed) to your K-State drop box before the due date.

Conjunctive Normal Form (CNF) converter

In this assignment you will complete your program to partially parse first order predicate calculus (FOPC), *aka* first-order logic (FOL) sentences, into CNF, i.e., clausal form. This consists of the UDOR stages.

Preliminary for CIS 530 students and CIS 730 students who did not complete MP4-5: Refer to the specification from MP4 for all problems. You will need to parse FOL sentences for this problem, just as you did in MP4. If you dropped MP4 or did not complete MP4-5, see the instructor for a hint on the following part.

Implement full Skolemization to eliminate all existential quantifiers. Demonstrate the correctness of your solution on the sample sentences (to be posted), and make sure that Skolem *functions* are generated with the right set of arguments when there are enclosing universal quantifiers.

1. **(530/730) Handling Parentheses.** Make sure your parser can handle parentheses properly, e.g.:

$$(a \wedge b) \vee c$$
$$(a \wedge b \wedge c) \vee (d \wedge e)$$

Reference: Handout, excerpt from Nilsson and Genesereth (Chapter 4).

2. **(530/730) Distributive Law.** Now for the hard(er) part: Drop all universals and implement full distribution to obtain a parse tree in conjunctive normal form (CNF), i.e., a conjunction of disjunctive *clauses*. Print out the redistributed version with proper parenthesization.

$$(a \wedge b) \vee c \equiv (a \vee c) \wedge (b \vee c)$$
$$(a \wedge b \wedge c) \vee (d \wedge e) = (a \vee d) \wedge (a \vee e) \wedge (b \vee d) \wedge (b \vee e) \wedge (c \vee d) \wedge (c \vee e)$$

3. **(530/730) Implicitization of Operators and Renaming Apart of Variables.** Complete the OR steps of the INSEUDOR procedure for conversion to CNF, as specified in Nilson and Genesereth.
4. **(730 only) FOPC Test Cases.** Test your CNF converter with the “good, bad, and ugly” test cases that will be given in class on Fri 26 Oct 2007 and posted on the CIS 730 course page.
5. **(730 only) The Inferential Frame Problem, Situational Calculus, and Resolution Strategies.** What resolution strategies apply in classical planning with the situational calculus? Suggest one that might help to combat the *inferential frame problem*.

Class participation (required). Post a one-paragraph synopsis of your term project progress to CIS730-L, in advance of mid-semester interviews next week (the week of Mon 29 Oct 2007).

Extra credit (5 points): Simple Resolution. Implement a resolution procedure for propositional logic, which takes two disjunctive clauses with a single pair of propositions that match, and outputs the resolvent.

$$(FOO \vee BAR) \wedge (\neg BAR \vee BAZ \vee \neg BAH) \vdash FOO \vee BAZ \vee \neg BAH$$

Note: This procedure need only match propositions; it does not need to find a unifier (even for ground terms).

Coming Up Next

Note the revised due dates for MP6, MP8 and PS9, to allow a full weekend for MP6 and PS9, and two full weekends for MP8. The due dates for PS7 and MP10 have **not** changed.

- Problem Set 7 (due Fri 02 Nov 2007) – Artificial Neural Networks and Probabilistic Reasoning
- Machine Problem 8 (due Mon 12 Nov 2007) – Probabilistic Reasoning
- Problem Set 9 (due Mon 19 Nov 2007) – Machine Learning
- Machine Problem 10 (due Fri 30 Nov 2007) – Term Project Experiment